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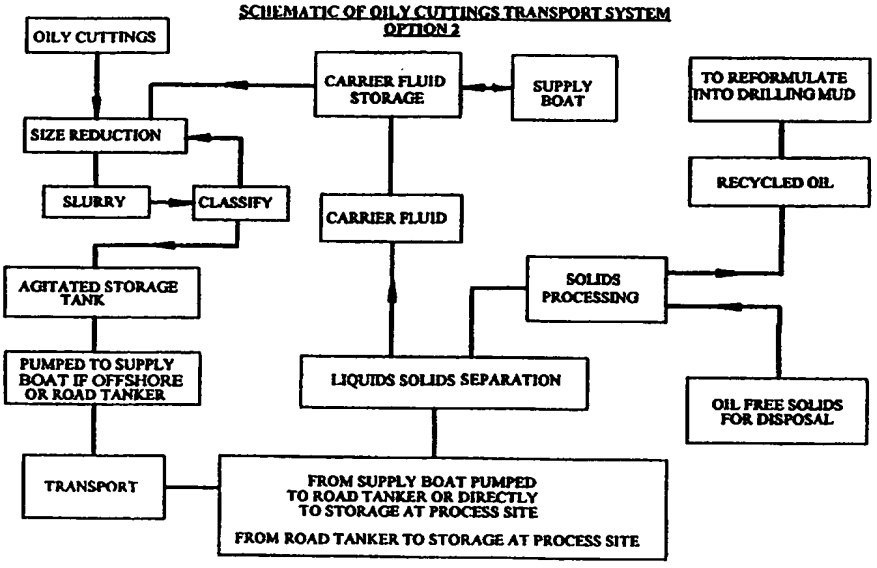

(57) Abstract

A method is described of treating solids generated during a drilling process for storage and transportation wherein cuttings from downhole are separated from the drilling fluid and mixed with a carrier fluid to form a slurry to allow the mixture to be pumped along pipes. The slurry is conveyed from the drilling site to a processing site, at which the cuttings are separated from the carrier fluid, and the latter is returned to the drilling site for re–use. Cuttings generated by an offshore semi–submersible platform drilling rig can be so treated.

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METHOD AND APPARATUS FOR THE TRANSPORT AND STORAGE OF DRILL CUTTINGS

Field of invention

This invention concerns method and apparatus for transporting and storing materials, especially oily particulate materials.

Background to the invention

During the drilling of an oil or gas well significant volumes of cuttings are generated. In the event that an oil based drilling fluid is used, employing either a mineral oil, refined oil or a synthetic substitute, the cuttings once separated from the drilling fluid retain a coating of that fluid. Depending upon the legislation applicable to the drilling location it may be required that the cuttings are contained and processed to remove all or most of the oil or synthetic oil prior to disposal.

Processing facilities are often remote from the drilling location, requiring the cuttings to be transported to the process point. A common practice is to collect the cuttings as they are removed from the solids control equipment in containers for storage and transport. Such containers are typically industrial skips or purpose designed units. Once filled the containers will be loaded by forklift or crane onto trucks for road transport (if the location is onshore), and if the location is offshore the containers will be loaded by crane onto a supply boat for transport to the dockside for unloading by crane to road transport, or directly to the processing station, if this is at the dockside.

At the processing point the container must be unloaded, cleaned, inspected, repaired if damaged and subsequently

returned for refilling at the drilling site. The movement of drill cuttings using this method thus involves significant investment in containers and handling equipment, is slow, manpower intensive, and can be prone to accidents occurring.

Where a significant volume of cuttings is to be handled, as can be the case during the drilling of large diameter upper hole intervals with fast penetration rates, the handling of the cuttings can become a limiting factor on the rate of drilling.

It is known to recover cuttings from the mud pumped up from downhole, to remove oil from the cuttings and to dump the cuttings at sea off the rig, and to mix fresh mud with that recovered from the cuttings cleaning process for pumping downhole. After a time the mud to be pumped downhole becomes so contaminated with fines and other contaminants that a more advanced cleaning process is required than can be performed on the rig, and it is known to return the contaminated mud (albeit without the cuttings) to a shore based mud processing facility using the supply vessel tanks. Thus after delivering fresh mud to the storage tanks on the rig, the contaminated mud no longer suitable for recycling on the rig, is pumped into the tanks of the supply vessel and the latter conveys the spent mud to the shore based reprocessing facility from which high quality mud can be recovered for transfer once again to the rig via the supply vessel. Thus apart from making good the losses which occur during the process, the mud system is essentially a closed loop system when taking into account the shore based reprocessing facility.

Under current legislation, cleanings can no longer be dumped at sea unless they have been cleaned to a very high level of purity. The removal of all traces of drilling mud components from the cuttings is difficult to perform on a drilling rig, and consequently the cuttings recovered from the mud pumped up from downhole have tended to be stored in containers on the deck of the rig and transferred from the rig to the supply

vessel using a crane mounted on the rig. In order to provide a ready supply of empty containers for filling with these cuttings, the supply vessel has to bring empty containers to the rig and these are craned off the vessel and replaced with the filled containers from the rig. This is a time consuming process which ties up the vessel for a considerable time which is not always desirable, and in some situations due to weather conditions, may be either dangerous or well nigh impossible.

Furthermore the storage of the filled containers on the deck of the rig can alter the stability of the rig and in bad weather conditions this can become hazardous.

The present invention seeks to provide an improved method for conveying cuttings at the rig site between the rig and the transport means, between the transport means and storage at the processing location, and from storage at the processing location to the processing facility.

The invention also provides an improved method for storage of cuttings both at the well site, during transport and at the processing location.

The invention

According to one aspect of the present invention solids generated during a drilling process are separated from the drilling fluid, and mixed with a carrier fluid to form a slurry to allow the mixture to be pumped along pipes.

If required the cuttings may be reduced in size prior to, during, or after slurrying.

Typically the solids should be below 5mm in diameter, as larger particulates are more difficult to maintain in suspension in a slurry. However they should not be significantly reduced below that size since smaller solids are more difficult to

separate from the carrier fluid at the processing location, and when separated tend to carry forward a larger quantity of liquid/drilling mud and/or carrier fluid, due to the increased surface area of small particles compared to that of larger particles.

The slurry is typically between 25 and 70% by volume, solids concentration.

The slurry may be stored before and/or after transportation from the drilling site, and in accordance with a second aspect of the invention the slurry is frequently agitated during storage to prevent settlement occurring.

Typically the slurry is conveyed from a drilling site to a processing site at which the cuttings are separated from the carrier fluid, and the carrier fluid may be returned to the drilling site for re-use.

The slurry may be conveyed to the processing site in bulk using road transport alone in the case of shore based drilling and processing sites, or by ship (and road transport if required), if the drilling is offshore.

The slurry may be stored at the processing site before processing.

The carrier fluid may be returned in bulk to the drilling site using similar transportation means.

Wherever the slurry is to be stored in a tank preferably the tank includes agitation means to maintain the solids in suspension.

Where the slurry is to be transported in bulk by road or water, in a tank, the solids are kept in suspension in the carrier fluid by frequently agitating the slurry or the tank within

which the slurry is contained, to prevent settlement occurring, and any storage tank on any transportation means includes means for achieving the slurry agitation.

According to another aspect of the invention there is provided apparatus for treating solids by-products from a well drilling site which includes well drilling means, drilling mud storage means, pump means for pumping mud downhole, means for collecting mud returning from downhole, solids separation means for removing solid material including drilling cuttings from the recovered mud, and mixing means for mixing the mud recovered with fresh mud for pumping downhole again, the said apparatus comprising means for mixing a carrier fluid with the recovered solids to form a slurry, storage means for storing the mixture of recovered solids and carrier fluid in the form of the slurry, agitation means for maintaining the solids in suspension whilst stored, and means for transferring the slurry from the storage means to a container for transfer to a solids processing site.

Preferably the solids separation means includes filtering means for removing from the solids particles larger in size than that which will reliably remain in suspension in the chosen carrier fluid.

The cuttings may be separated from the drilling mud during the drilling of the well using conventional solids separation equipment.

Cuttings collected from the solids control equipment either may be mixed with carrier fluid to form a slurry in or near the separation equipment, or may be conveyed to a remote point for slurrying.

Preferred carrier fluid

Ideally the carrier fluid should support the solids in

suspension without the need for agitation of the fluid, but should be pumpable or flow by gravity when required.

If adequate agitation is available during slurry storage and conveyance the carrier fluid may be of a lesser specification.

Preferably the carrier fluid is such as to prevent the cuttings becoming exposed to free water with which the cuttings could react.

Depending on the solids support required, carrier fluid may be oil, viscosified oil, oil based drilling mud, synthetic oil based drilling mud, or any other fluid that will maintain solids in a stable condition and will support the solids in suspension as a slurry.

According to a preferred feature of the invention, the carrier fluid is thixotropic - that is its viscosity is greater when it is stationary than when flowing.

Drilling mud is generally thixotropic but the thixotropic properties of ordinary drilling mud may not be sufficient to guarantee the suspension of larger sized particles, and where this is the case a carrier fluid is formed by adding to normal drilling mud additional viscosifying and/or gelling and/or emulsifying and/or oil wetting agents, so as to produce the required additional thixotropic and other desirable properties of the carrier fluid.

The thixotropic properties of ordinary drilling mud may be enhanced by the addition of a packer fluid such as Kenex packer fluid as employed in pipeline bounding sleeves to prevent (or reveal in the event of), damage to pipelines where the latter extend below roadways and the like.

Preferably any so-called packer fluid which is added, is compatible with drilling mud, so that if traces of it become

mixed with mud which is subsequently to be pumped downhole, serious problems do not arise.

Where the cuttings are reduced in size prior to, during or after slurrying, the step of reducing the size of the solids may be followed by screening or solids classification to remove and recycle any oversize particles, so that only the maximum size of particle which will remain in suspension in the given carrier will remain in the slurry.

Classification may be achieved by simply filtering for size, and if appropriate returning oversize particles to the size reduction step in the process from where they can be once again supplied to the classifying stage.

The use of an enhanced drilling mud as the carrier fluid is particularly advantageous in the case of offshore drilling rigs to which consumables are supplied by ship and from which by-products such as oily cuttings are transported by ship back to a shore based cuttings processing facility where the oily cuttings are cleaned for landfill or other legitimate disposal. By using a mud based carrier, the same tanks as are employed for transporting fresh supplies of basic drilling mud to the platform can be used as the transport medium for conveying the slurry of cuttings from the rig to the shore based cuttings processing facility, provided that all of the ingredients added to the basic drilling mud to form the slurry are compatible with ordinary drilling mud and if not wholly removed from the mud before the litter is reused, will not affect the downhole characteristics of the mud.

By using a mud compatible carrier fluid typically an enhanced drilling mud, the invention obviates the need to transfer containers from shore to rig and vice versa, and enables the storage tanks on the supply vessel which on the journey from shore to rig are filled with fresh drilling mud, to be filled with the carrier fluid and cuttings slurry for the return trip.

By its nature, the slurry can be rapidly pumped from the rig to the ship and from the ship to shore. This means that the rig mounted crane is not tied up for long periods of time shifting containers from ship to rig and vice versa, as is required using conventional solids treatment methods and the hazardous storage of containers full of cuttings on the deck of the rig is also obviated.

The slurry of cuttings and carrier fluid of course has to be stored on the rig, but since it is a fluid which can be pumped, the storage means can comprise tanks at a low level on the rig or in an adjoining pontoon, to which the slurry is supplied either under gravity or with pumped assistance, and from which the slurry can be pumped via a pipeline to the supply vessel for the return trip to the processing facility on the shore. The stability of the rig is therefore significantly improved since the weight of the stored slurry can now be at or below seal level.

The shore based facility may recover any additives which have been included with the basic drilling mud to form the enhanced mud/carrier fluid, and the additives and recovered drilling mud may be returned separately to the drilling rig, in separate tanks on the supply vessel, during a return trip. The recovered additives and freshly processed mud may be stored on the rig. The drilling mud recovered on the rig from the mud and solids from downhole using conventional solids separation equipment, can be combined with fresh mud for pumping downhole, and when required the selected proportions of the additives can be added to fresh or recovered mud to form a carrier fluid for cuttings from downhole, and a slurry can be formed by combining the cuttings with the carrier fluid which is then stored on the rig for subsequent pumping to a supply vessel, to be returned to a shore based mud recovery and cuttings cleaning plant.

In order to ensure any solids left in the transportation tanks do not get picked up and conveyed to the rig with fresh cleaned

drilling mud, the tanks may be washed through and/or filters may be provided to prevent any such solids/cuttings from leaving the tank and being conveyed to the mud storage tank(s) on the rig.

The additional solids and liquid handling facilities on an offshore drilling platform therefore comprise a slurry mixing system for mixing a carrier fluid with the cuttings separated from the mud recovered from downhole, and a transfer pump for conveying the slurry to a storage tank on the rig or on a pontoon associated therewith.

Using drilling mud as the base for the carrier fluid means that an offshore drilling platform only requires the addition of one or more tanks for storing the slurry, and tanks for storing the additives to be mixed with drilling mud to form the carrier fluid.

The slurry storage tanks may need to include agitation means either of the tank or of the contents, or both, so as to ensure that the solids remain in suspension and do not settle out.

By ensuring that the carrier fluid is fully compatible with drilling mud, the same pipeline can be used for conveying the slurry to the slurry holding tanks as is used for conveying fresh mud from a supply vessel to the mud storage tanks on the rig or associated pontoon, and for conveying slurry from the slurry storage tanks on the rig or pontoon to the supply vessel, for return to shore.

The technology of adjusting the mud parameters of viscosity, solids holding capability, emulsification and oil wetting is well known to the oil industry, as are the mud compatible materials to achieve these parameters. Selecting a suitable mixture of such chemicals to obtain the desired enhancement of a basic drilling mud so as to form a carrier fluid having the characteristics required by the present invention, therefore

should be within the capabilities of any competent drilling or solids control engineer.

Where agitation of the slurry is required at all times, then the mud storage tanks on the supply vessel which are to be used for conveying the slurry from rig to shore, may need to be modified so as to provide for frequent (eg regular or continual) agitation of the contents of the tanks.

Improved drilling rig

The invention thus also lies in an offshore drilling rig having incorporated therein or in a pontoon alongside, additional storage tank facilities for storing at low level (at or below sea level) a slurry of drilling cuttings from downhole in suspension in a thixotropic carrier fluid, agitation means for agitating the slurry in the tank facilitates to prevent solids settlement, pipe means for conveying slurry from the storage facilities to a tank on a supply vessel and pump means for pumping slurry from the storage facilities through the pipe means.

The invention also lies in an improved offshore drilling rig as aforesaid which includes further tank means for storing additives to be mixed with drilling mud to form the carrier fluid, mixing means for mixing drilling mud and selected quantities of the additives to make up a carrier fluid, pump means for transferring carrier fluid to a mixing chamber to form a slurry with cuttings from downhole, and means for transporting the slurry to the said additional tank facilities on or associated with the rig.

Land based drilling site

Preferably the slurry is stored in bulk prior to transfer from the drilling site, in a tank containing agitation means.

Where the drilling site is sufficiently close to the processing site transfer of slurry from the drilling site to a processing site may be effected by pumping along a pipeline.

Typically however the slurry is pumped and/or allowed to run by gravity from the storage tank into a tank on a road transporter, and after transportation the slurry is unloaded by pumping and/or by gravity into a suitable storage facility.

Separation of cuttings from carrier fluid

Whether recovered from a land based site or an off-shore drilling rig, drilled cuttings may be removed from the carrier fluid using solids separation equipment similar to that used for separating cuttings from drilling mud at the drillhead, and following separation the solids are then processed typically for landfill, and the carrier fluid may be returned for re-use at the drillhead, or may be separated into a conventional drilling mud fraction and one or more additive fractions for return to the drillhead. By using compatible additives the fluid(s) may be transferred in the reverse direction from the processing site to the drillhead using the same pipeline and/or tanks on the road transporter or supply ship, typically tanks which are empty after delivery of slurry to the processing site.

Advantages of the invention are:

1. The solids are easily, quickly and safely stored at the drilling rig.

2. The slurry is easily conveyed from a drilling rig to a supply boat, and onward from the supply boat to the point of processing, using pumps and hoses which are normally present in existing installations on the rig. The transfer of slurries using these components, and the procedures for their use, are known and understood.

3. No additional hazards over those currently experienced in slurry transfer are created.

4. The method of transfer is not manpower intensive and the need to use rig and dockside cranes for long periods, is eliminated, as is the need for a crane at the final point of processing.

5. The method eliminates the need for multiple, possibly specialist containers, and extensive mechanical handling of these containers on the rig and at the process site. Thus where a rig mounted crane would be required for this purpose, it can be freed-up for transporting other commodities to and from the rig and supply vessel.

6. The method eliminates the requirement for inventory control, cleaning, repair, maintenance, certification and documentation of multiple containers.

7. The use of a carrier fluid that is drilling mud or is compatible with drilling mud allows the cuttings to be maintained in a stable state. This will allow the cuttings to be easily separated from the carrier fluid.

8. The use of a carrier fluid that is based on drilling mud or is comparable with drilling mud, reduces the risk of contamination during transfers on the rig and supply boat, and reduces the requirement for tank cleaning. It also permits the use of the same tanks on a supply vessel (or road transporter) for the transport of slurry from rig to cuttings processing and recovery facility, as are used for transport of mud products to the rig.

9. The maintaining of the cuttings in a stable state with minimum exposure to water reduces the complexity, difficulty and energy requirement for subsequent processing.

10. By appropriate choice of carrier fluid a high volume of solids can be incorporated into it, resulting in volumetrically efficient transport means.

11. The weight and space requirements resulting from the storage of multiple small containers on deck will normally be larger than that required for bulk storage of similar volumes of solids.

12. The position of storage of slurry on the drilling rig can be flexible and is dependent only on the availability of suitable tanks, ie slurry could be stored in pontoon or tanks below deck. This flexibility has significant advantages for offshore drilling rigs where storage of large volumes of cuttings may be achieved while minimising the impact of the additional weight on variable deck load and rig stability. Where moderate volumes of slurry storage is required for limited periods only, temporary deck tanks may be employed quickly and easily.

13. Once the cuttings are constituted into slurry form they may be easily and flexibly transferred between points on the drilling location.

14. The transfer rate of cuttings from the rig to the supply boat or road transport would normally be expected to exceed that achievable using containers. This reduces the loading time required for the supply method. This is of particular importance for an offshore drilling rig where the period when a supply boat can stand by the rig may be limited by weather. In addition the cost of the supply boat can be reduced if the loading cycle times at the rig and dock can be reduced.

15. The invention essentially uses the existing infrastructure of a typical offshore drilling rig with few modifications.

Although the invention is most effective when employed in a

closed loop system in which compatible materials are employed for carrying the cuttings solids in suspension in the slurry, the invention is not restricted to closed loop arrangement and is equally applicable to open loop systems in which the carrier fluid may or may not be compatible with the drilling mud, and in which there is no advantage or need, or little or no attempt is made to utilise the same tanks or pipelines for drilling muds, slurry, carrier fluids etc, and/or in which no attempt is made to return any recovered fluid from the remote cuttings cleaning and disposal facility.

The invention will now be described by way of example with reference to the accompanying drawings in which:

Figures 1 to 3 comprise schematic diagrams of oily cuttings transport systems incorporating the invention, in which in Figure 1 the source of the drilling cuttings is a well drilling facility and transfer of the slurry is by boat or road tanker, in Figure 2 the cuttings are reduced in size after being mixed with carrier fluid to form a slurry, and in Figure 3 the cuttings are reduced in size before being mixed with carrier fluid to form the slurry;

Figure 4 is a schematic of a conventional offshore semi-submersible drilling rig mud transport system, from dock to rig; and

Figure 5 is a similar schematic to Figure 4, modified to incorporate the slurrying step of the invention, using mud-compatible carrier fluid.

In all three operations the processing site includes a liquid/solids separation. Such may comprise a VSM100 shale shaker and/or a decanting centrifuge as supplied by Rig Technology Ltd of Aberdeen. Recovered carrier fluid is returned to the drilling site for mixing with oily cuttings from downhole or for shipment via land and/or sea back to the

drilling site.

The solids recovered from the slurry are further processed to remove all liquid from the solid material which is then free to be disposed of for example as landfill, and the recovered oils (drilling mud components) are stored for future use. For example they may be recycled as by reformation into drilling mud, for use at the original drilling site, or at other drilling sites.

Figure 4 shows an offshore drilling rig facility and shore to rig supply boat system, operating in the conventional known manner to handle the oily drilling cuttings, using deck containers and cranes.

In Figure 4 an offshore drilling rig is shown diagrammatically at 10 floating semi-submerged with sea level shown at 12 and the sea bed at 14. A drill bit 16 at the lower end of a drill pipe 18 is shown excavating downhole forming the bore hole 20 and a casing 22 is shown sealing the bore hole 20.

The drill pipe 18 is hollow and drilling mud is pumped downhole through the hollow interior of the drill pipe 18 by means of a high pressure mud pump 24. Active drilling mud storage and treatment tanks are shown at 26 and mud for pumping downhole is supplied from the storage tanks to the pump 24.

In known manner, the drill bit is formed with openings through which the mud flows into the bore hole and fills the latter to the top of the casing 22 from which it is recovered. The action of drilling creates small rock particles known as cuttings which mix with the mud, and because of its properties, are carried by the mud to the top of the drill casing 22. A mud/cutting separation system such as a shale shaker and centrifuge is supplied with the recovered mud and cuttings, and is denoted by reference numeral 28.

Storage tanks and transfer pumps are located below sea level in the rig pontoon and the transfer pumps are denoted by reference numerals 30 and 32 and the mud storage tanks are denoted by reference numeral 34. A transfer pipe is denoted by reference numeral 36 enabling fresh mud to be transferred into the storage tanks 34 and when required for drilling, to be pumped from the storage tank 34 to top up the storage tank 26 and to be mixed with the recovered mud from the solids separation system 28.

Various valves generally designated 38 allow for the transfer of liquids to and from the tanks 34 utilising the pumps 30 and 32.

Similar valves 40 and 42 facilitate the transfer of mud from the tanks 34 to the tank 26 or the transfer of fresh mud from a supply vessel.

To this end a supply vessel is denoted by reference numeral 44 and a transfer hose 46 is shown connecting the supply vessel to the valve 42. The vessel includes storage tanks ~~46~~ 47 and transfer pumps 48 and 50 and associated control valves generally designated 52. If permitted, cuttings recovered from the mud in the separation stage 28 can be dumped overboard as denoted by 54.

Alternatively and more commonly, the cuttings are too oily and otherwise contaminated to be dumped in this way, and it has become commonplace to bring empty containers to the rig on the supply vessel for filling with oily cuttings from the separation stage 28, and to crane the filled containers from the deck of the rig onto the supply vessel to allow the latter to transport the oily waste cuttings to a shore based processing plant.

The mud recovered from the separation equipment 28 will contain small particles, and the continual re-circulation of such mud

(albeit with the addition of fresh mud from the storage tanks 34), causes the solids content of the mud to build up with time. Eventually the active mud on the rig has become so contaminated with solids that it needs to be further processed before it can be reused. The now useless mud is pumped into the empty tanks on the supply vessel when the latter has delivered a fresh supply of mud to the rig, and the vessel transfers the solids contaminated mud from the rig together with containers full of oily cuttings to the shore based facility where the cuttings can be more efficiently cleaned ready for dumping as landfill. The high solids content mud can be pumped via transfer hose 56 from the tanks of the supply vessel into a first storage tank 58 from which it is pumped by means of a transfer pump 60 to a reprocessing system 62 for recovering the liquid content of the contaminated mud and separating the fines therefrom.

The cleaned mud is pumped by transfer pump 64 to a final storage tank 66 which contains refined drilling mud ready for re-use on the rig, and this can be pumped to the supply vessel via transfer pump 68 and pipeline 70 with the appropriate setting of the valves designated 72 so that the supply vessel can return to the rig fully loaded with fresh drilling mud.

Figure 5 illustrates the conventional offshore rig and shore to rig supply vessel, modified in accordance with the invention.

In Figure 5 similar components which also appear in Figure 4 are identified by the same reference numeral as employed in Figure 4, and reference should be made to the description Figure 4 for details of those similarly identified parts of Figure 5.

However in Figure 5 the pontoon mounted tanks 34 are replaced by a mud tank 74 and a carrier fluid storage tank 76. The valves generally designated 38 can be adjusted so that transfer

pumps 30 or 32 can be operated to deliver the carrier fluid via valve 78 to a slurry mixing system 80 to which cuttings are supplied from the mud/cuttings separation stage 28. A tank 82 provides temporary storage for the carrier fluid and cuttings slurry.

Pump 84 can be operated when valve 86 is opened to convey the slurry via the transfer hose 46 to one or more tanks such as 47 on the supply vessel 44, for transport from the rig to a shore based slurry treatment facility. The transfer hose 46 also serves to convey fresh carrier fluid and/or mud and/or enhancement additives for converting used mud to a carrier fluid, from the tanks of the supply vessel to the appropriate storage tanks on the rig.

The valves associated with the transfer hose and various tanks must of course be opened and closed as appropriate in manner known per se.

The shore based facility shown in the lower part of Figure 5 is similar to that in Figure 4, but includes a second facility for handling the slurry of carrier fluid and cuttings. To this end mud containing a high content of fines (such as solids materials) can be reprocessed in the manner described in relation to Figure 4 by the lower one of the two processing lines, and thereafter pumped from one of the tanks on the supply vessel into the drilling mud storage tank 58 as previously described.

Alternatively by appropriately closing the valve 88 and opening valve 90, the slurry of carrier fluid and cuttings contained in one of the other tanks on the supply vessel can be pumped by an appropriate transfer pump on the supply vessel into the storage tank 92. The slurry can be transferred by means of pump 94 to a carrier fluid/cuttings separation system and reprocessing facility 96. From this oily cuttings are separated before subsequent processing along line 98 and

transfer pump 100 transfers the cleaned carrier fluid into a further storage tank 102 from which it can be pumped by transfer pump 104 and along line 106 through valve 108 when open, back into an empty tank on the supply vessel for returning the carrier fluid to the rig.

Alternatively (not shown) the carrier fluid may be divided into separate fractions comprising some or all of the original liquids making up the carrier fluid, such as basic drilling mud and additives, and the different fractions stored and transported back to the rig as required.

CLAIMS

1. A method of treating solids generated during a drilling process for storage and transportation wherein cuttings from downhole are separated from the drilling fluid and mixed with a carrier fluid to form a slurry to allow the mixture to be pumped along pipes.

2. A method of solids treatment as claimed in claim 1, further comprising the step of reducing the particle size of the cuttings before, during or after the mixing step, to a size which will reliably remain in suspension in the chosen carrier fluid.

3. A method of solids treatment as claimed in claim 1 or 2, wherein the slurry is frequently agitated to prevent settlement occurring.

4. A method of solids treatment as claimed in claim 1, 2 or 3, wherein the slurry is conveyed from a drilling site to a processing site, at which the cuttings are separated from the carrier fluid.

5. A method of solids treatment as claimed in claim 4, wherein the carrier fluid is returned to the drilling site for re-use.

6. A method of solids treatment as claimed in claim 5, wherein the carrier fluid is separated into different fluid components before or after being returned to the drilling site.

7. A method of solids treatment as claimed in claim 4, wherein the slurry is transported in a tank and the solids are kept in suspension in the carrier fluid by frequently agitating the slurry or the tank or both to prevent settlement occurring.

8. Apparatus for treating solids byproducts from a well drilling site which includes well drilling means, drilling mud storage means, pump means for pumping mud downhole, means for collecting mud returning from downhole, solids separation means for removing solid material including drilling cuttings from the recovered mud, and mixing the recovered mud with fresh mud for pumping downhole again, characterised by means for mixing a carrier fluid with the recovered solids, storage means for storing the mixture of recovered solids and carrier fluid in the form of a slurry, agitation means for maintaining the solids in suspension whilst stored, and pipe means for transferring the slurry from the storage means for transfer to a solids processing site.

9. Apparatus as claimed in claim 8, wherein the solids separation means includes filtering means for removing from the solids particles larger in size than that which will reliably remain in suspension in the chosen carrier fluid.

10. Apparatus as claimed in claim 8 or 9, further comprising size reducing means for reducing the particle size of the cuttings forming the slurry.

11. Apparatus as claimed in claim 8, 9 or 10, wherein transfer to the processing site is effected using a tank on a ship and/or road transporter.

12. A carrier fluid as claimed in any of the preceding claims, whose viscosity is greater when it is stationary than when flowing.

13. A carrier fluid as claimed in claim 12, comprising oil, viscosified oil, oil based drilling mud or synthetic oil based drilling mud.

14. A carrier fluid as claimed in claim 12, comprising a mixture of thixotropic drilling mud and additional viscosifying

and/or gelling and/or emulsifying and/or oil wetting agents.

15. A carrier fluid as claimed in claim 12, comprising a mixture of thixotropic drilling mud and a packer fluid.

16. A method of treating cuttings from downhole generated by an offshore semi-submersible platform drilling rig to which drilling mud is supplied by pumping from a supply ship, and from which by-products such as oily cuttings are transported by the ship back to a shore based cuttings processing facility where the oily cuttings are cleaned, characterised by the steps of mixing the cuttings with a carrier fluid to form a slurry, storing the slurry in a slurry retention tank located low down on the platform, pumping the slurry from the slurry retention tank into a tank on a ship which has conveyed drilling mud to the platform, transporting the slurry to a shore based retention tank and pumping the slurry from the ship's tank into the shore based retention tank to await processing.

17. A method as claimed in claim 16, wherein the carrier fluid is drilling mud and additives to enhance at least its thixotropic properties.

18. A method of treating cuttings as claimed in claim 16 or 17, wherein the on-shore processing involves separating the cuttings from the carrier fluid.

19. A method of treating cuttings as claimed in claim 18, wherein the recovered carrier fluid is returned to the rig in a supply ship's tank.

20. A method of treating cuttings as claimed in claim 16, 17 or 18, wherein the carrier fluid is drilling mud and additives and the processing on-shore involves the step of recovering any additives which have been included with a basic drilling mud to form the carrier fluid, and returning separately to the rig the additives and the drilling mud.

21. A method of treating cuttings as claimed in claim 20, wherein the drilling mud and additives returned to the rig are stored for future use, the mud is pumped downhole as required and subjected to conventional solids separation techniques on emerging from downhole carrying cuttings, the mud is re-used downhole and the cuttings are added to a carrier fluid made up of a mixture of drilling mud and selected ones of the additives, to form a slurry for storage and later shipment to shore for processing.

22. A method of treating cuttings as claimed in claim 24, wherein the carrier fluid is compatible with drilling mud and the slurry is conveyed to the platform slurry retention tank, fresh mud is conveyed from a supply ship to a mud storage tank on the platform and slurry is conveyed from the slurry retention tank to the supply ship's tank, using pump and pipeline means.

23. A method as claimed in claim 22 wherein the same pipeline is used to convey slurry to the platform retention tank as is used to convey drilling mud from ship to platform storage tank and slurry from the retention tank to the ship.

24. A method as claimed in claim 21, wherein the drilling mud is filtered before or after it is pumped from the ship to the platform storage tank, to remove any solids picked up by the drilling mud from residue in the ship's storage tanks.

25. An offshore drilling rig having incorporated therein or in a pontoon alongside, an additional storage tank for storing at low level a slurry of drilling cuttings from downhole in suspension in a thixotropic carrier fluid, agitation means for agitating the slurry in the storage tank to prevent solids settlement, pipe means for conveying slurry from the storage tank to a tank on a supply vessel, and pump means for pumping slurry from the storage tank through the said pipe means.

26. An offshore drilling rig as claimed in claim 25, which includes further tank means for storing additives to be mixed with drilling mud to form the carrier fluid, mixing means for mixing drilling mud and selected quantities of the additives to make up a carrier fluid, pump means for transferring carrier fluid to a mixing chamber to form a slurry with cuttings from downhole, and means for transporting the slurry to the said additional storage tank.

27. Methods and apparatus for treating cuttings from downhole generated during a drilling process substantially as herein described, and as illustrated in and described with reference to Figures 1 to 3 and 5 of the accompanying drawings.

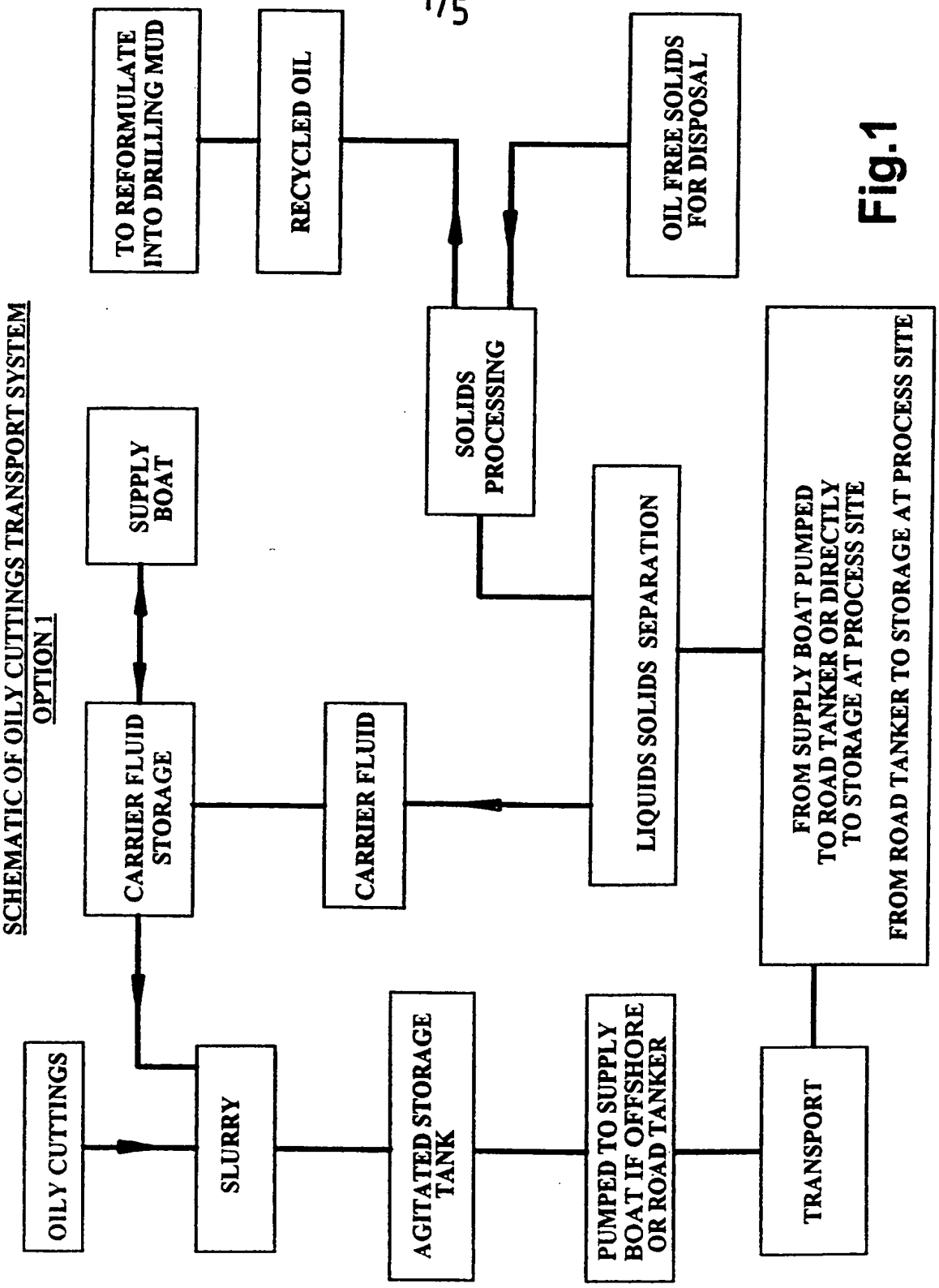
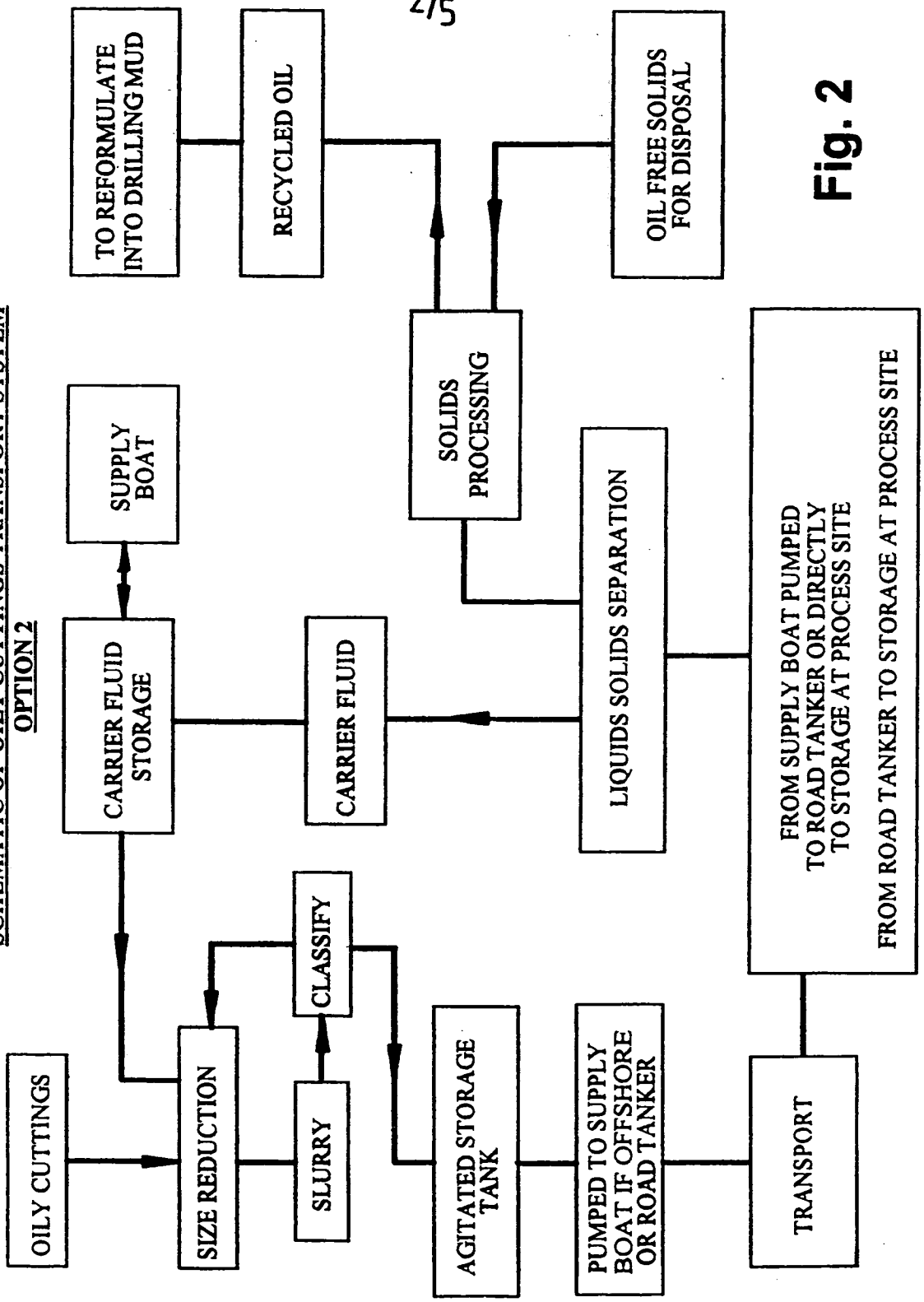

SCHEMATIC OF OILY CUTTINGS TRANSPORT SYSTEM
OPTION 1
OILY CUTTINGS
SLURRY
CARRIER FLUID STORAGE
SUPPLY BOAT
AGITATED STORAGE TANK
PUMPED TO SUPPLY BOAT IF OFFSHORE OR ROAD TANKER
TRANSPORT
CARRIER FLUID
LIQUIDS SOLIDS SEPARATION
SOLIDS PROCESSING
FROM SUPPLY BOAT PUMPED TO ROAD TANKER OR DIRECTLY TO STORAGE AT PROCESS SITE
FROM ROAD TANKER TO STORAGE AT PROCESS SITE
TO REFORMULATE INTO DRILLING MUD
RECYCLED OIL
OIL FREE SOLIDS FOR DISPOSAL

Fig.1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OPTION 2
OILY CUTTINGS
SIZE REDUCTION
SLURRY
CLASSIFY
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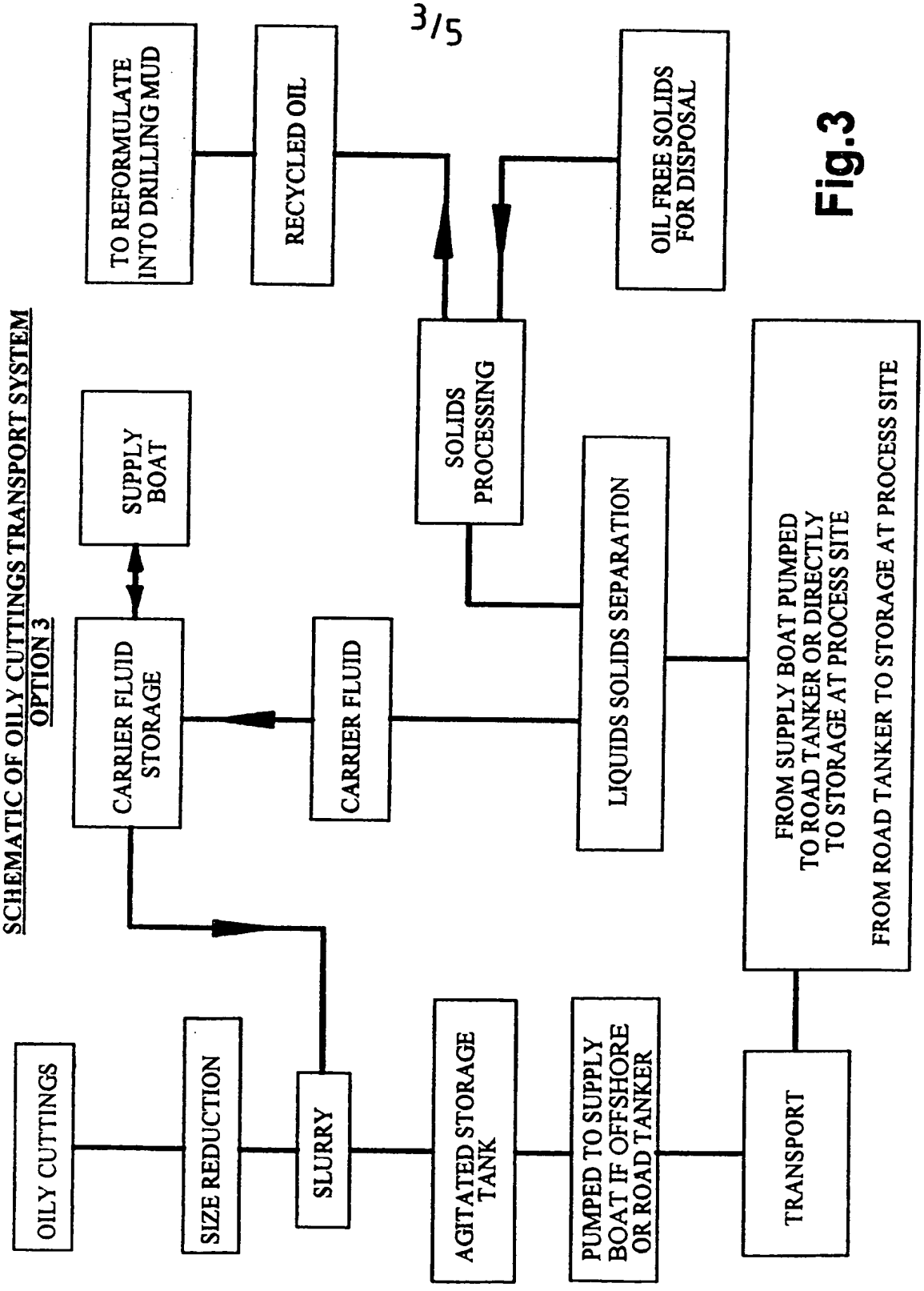
TRANSPORT
FROM ROAD TANKER TO STORAGE AT PROCESS SITE
FROM SUPPLY BOAT PUMPED TO ROAD TANKER OR DIRECTLY TO STORAGE AT PROCESS SITE
LIQUIDS SOLIDS SEPARATION
CARRIER FLUID
CARRIER FLUID STORAGE
SUPPLY BOAT
SOLIDS PROCESSING
OIL FREE SOLIDS FOR DISPOSAL
RECYCLED OIL
TO REFORMULATE INTO DRILLING MUD

Fig. 2


SCHEMATIC OF OILY CUTTINGS TRANSPORT SYSTEM
OPTION 3
OILY CUTTINGS
SIZE REDUCTION
SLURRY
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TRANSPORT
FROM SUPPLY BOAT PUMPED TO ROAD TANKER OR DIRECTLY TO STORAGE AT PROCESS SITE
FROM ROAD TANKER TO STORAGE AT PROCESS SITE
CARRIER FLUID STORAGE
SUPPLY BOAT
CARRIER FLUID
LIQUIDS SOLIDS SEPARATION
SOLIDS PROCESSING
TO REFORMULATE INTO DRILLING MUD
RECYCLED OIL
OIL FREE SOLIDS FOR DISPOSAL

Fig.3

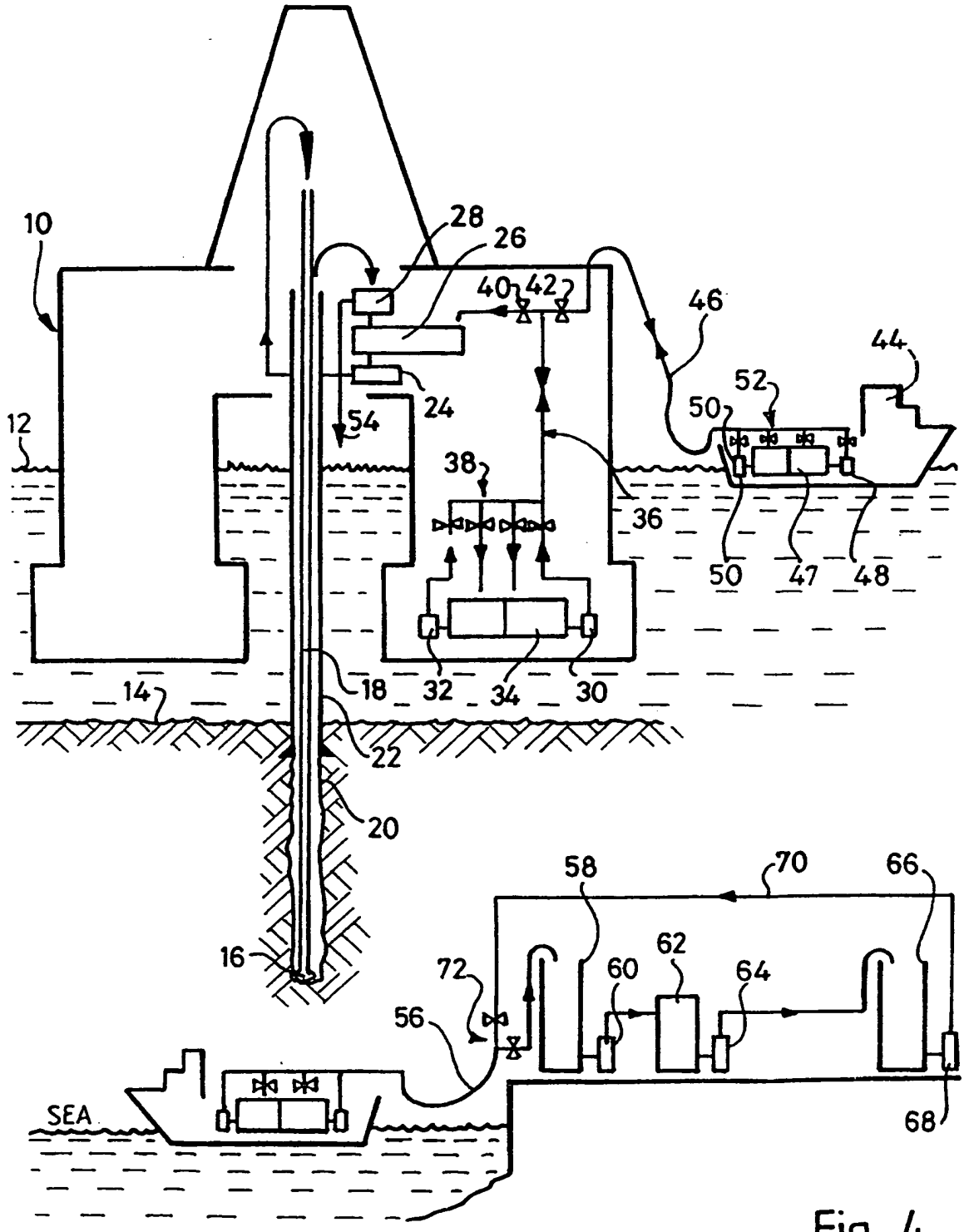
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Fig. 4

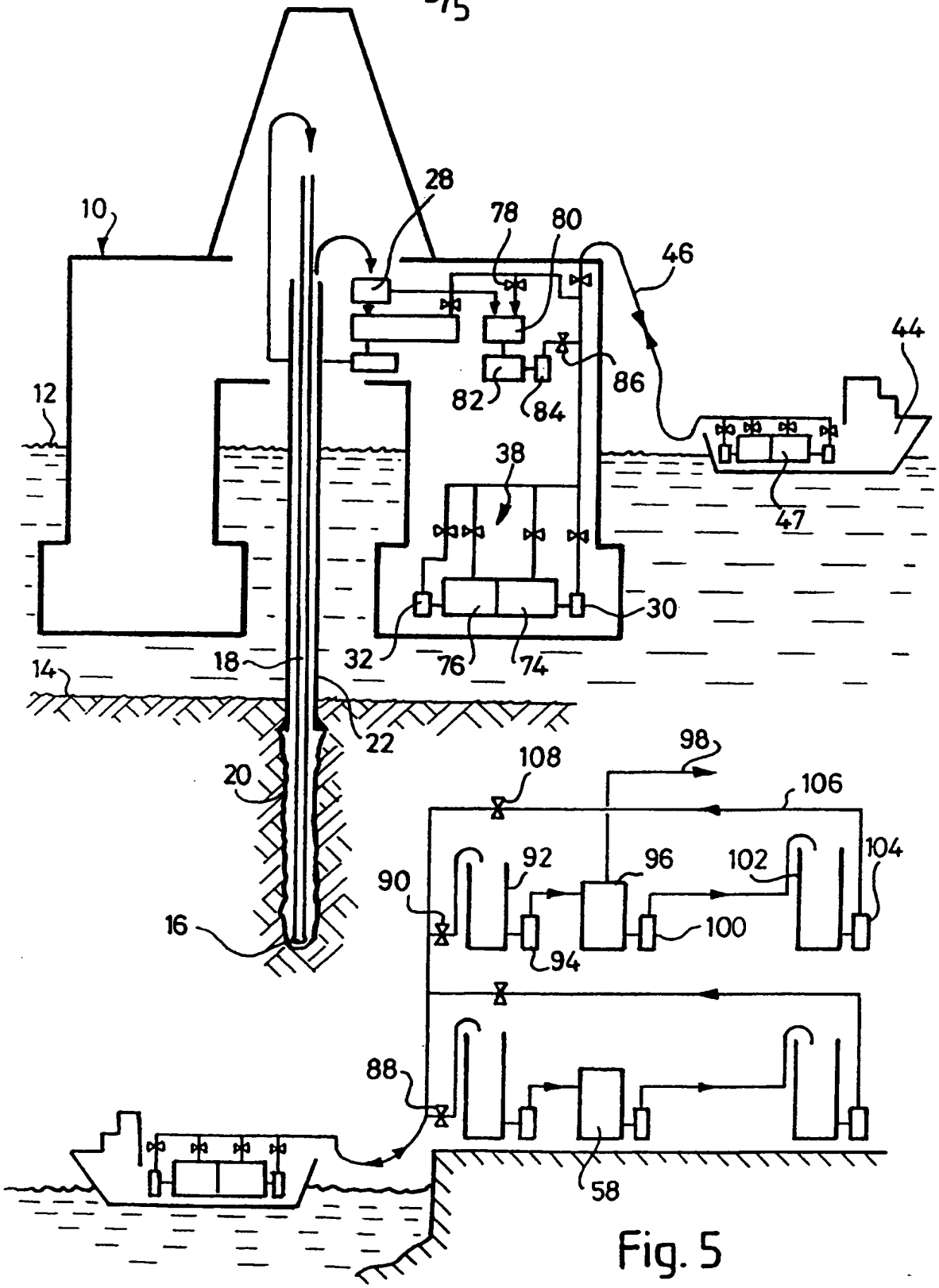
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Fig. 5

INTERNATIONAL SEARCH REPORT

Inte ›nal Application No
PCT/GB 98/03164

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 E21B21/06 E21B41/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 E21B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 303 786 A (PRESTRIDGE MARK L ET AL) 19 April 1994 see column 1, line 59 - column 2, line 6 see claim 1 see figure 1 ---	1-3
X	US 5 129 469 A (JACKSON JAMES E) 14 July 1992 see column 4, line 14-53 see figure 1 ---	1-3
X	GB 2 301 382 A (ATOMIC ENERGY AUTHORITY UK ;AEA TECHNOLOGY PLC (GB)) 4 December 1996 see page 3, line 14 - page 4, line 18 see figure 1 --- -/--	1,2

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"A" document defining the general state of the art which is not considered to be of particular relevance

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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
8 January 1999	15/01/1999

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Schouten, A

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INTERNATIONAL SEARCH REPORT

Inte. onal Application No
PCT/GB 98/03164

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
X	WO 93 20328 A (RIG TECHNOLOGY LTD ;BAILEY MARSHALL GRAHAM (GB)) 14 October 1993 see abstract see claim 1	1

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INTERNATIONAL SEARCH REPORT

Information on patent family members

Inter ...nal Application No
PCT/GB 98/03164

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GB 2301382 A	04-12-1996	NONE	
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